

REMARKS

The present application has claims 1, 3-5, 9-12 and 15-19 pending. Applicants herein have added new claim 20. Accordingly, claims 1, 3-5, 9-12 and 15-20 are now pending. Claim 20 was added in response to the comment made by the Examiner in the December 29, 2008 Office Action that "adhesion" was not present in any of the claims (see page 5, last paragraph, of the Office Action). Favorable consideration of new claim 20 is respectfully requested.

In the December 29th Office Action, the Examiner again rejects the pending claims as obvious to one of ordinary skill in the art over Fischer (DE 196 11 510) in view of Goller et al. (US Patent 4,185,131) and further in view of Campbell et al. (US Patent Pub. 2001/0009733). Applicants disagree with the Examiner's position for the following reasons and those presented in earlier responses.

Fischer teaches an ink composition comprising (based on 100g ink composition):

3.1 g Pt supported catalyst (30 wt% Pt/C)
30.9 g Nafion solution (5 wt% in 90:10 isopropanol:water)
37.2 g glycerine
24.8 g water
2.5 g hydroxide
1.5 g pore-former
100.0 g

This ink composition has 27.7g of water (24.8g plus 2.9g from the Nafion solution -- which is composed of 95% or 29.4g of 90:10 isopropanol:water, of which 10% is water).

The Examiner maintains that Goller teaches the functional equivalence of glycerine and ethylene glycol as organic solvents inking vehicles and that it would have been obvious to substituted ethylene glycol for the glycerine used in Fischer. The Examiner also maintains that Campbell teaches that it is well known in the art field to use aqueous ionomer solutions in catalyst inks, and, presumably, to substitute an aqueous ionomer solution for the 90:10 isopropanol:water solution of the Fischer reference.

First of all, the Examiner is using hindsight to come up with this combination. There is no teaching or suggestion in any of the references and the Examiner has not presented any motivation for one skilled in the industry to modify the ink composition of Fischer. As stated in the specification, Fischer has a high concentration of isopropanol -- requiring certain precautions be taken to prevent ignition of the catalyst (see page 3, lines 4-6). Additionally, the ink of Fischer can be processed only over a very short period of time due to the low boiling point of the isopropanol (see *Id.*, lines 6-9).

To overcome these problems, the prior art looked to water-based inks where the solvent is substantially water (see for instance, the specification page 3, line 26 through page 4, line 10). But these water-based inks have their own problems - such as poor adhesion of the electrode layers to the member which lead to inadequate electrical performance (see, page 4, lines 6-8, of the specification) and thickening of the ink during screen printing leading to inadequate screen life - the time period during which screen printing is possible (see, page 4, lines 8-10).

The present invention provides ink compositions which do not have the toxicity and flammability problems of organic solvent-based inks, nor the disadvantages outlined above typically associated with water-based inks. The inks of the present invention achieve these goals by a specific set of characteristics. None of the cited references teach or suggests using the ratio of the organic solvent to water in the ink to overcome the

above problems of organic solvent-based inks and those of water-based inks. And, certainly none of the references suggest the 5 to 25 wt.% range discovered by the inventors for achieving an ink that results in good electrical performance and good screen life while avoiding the toxicity and flammability problems of organic solvent-based inks.

Moreover, the combinations and assertions made by the Examiner are not proper. The present invention is directed to *water-based* inks -- which, as outlined above, are quite different from *organic solvent-based* inks. Accordingly, the inks of Fischer are not analogous to those of the present invention.

Furthermore, the combining of Fischer and Goller is improper. Contrary to the Examiner's assertions, glycerine and ethylene glycol are not equivalents -- that are routinely substituted for one another. As set forth in the specification (page 3, lines 9-11), membrane electrode assemblies made with inks containing glycerine require very long activation and conditioning periods before acceptable electrical performance is obtained. Accordingly, glycerine is unsuitable for use in the present invention.

In contrast to the use of glycerine, the present application specifies *particular linear dialcohols* that can be used in the subject invention -- i.e., dihydric alcohols having two hydroxyl groups in their linear, chain-shaped, molecular structure, wherein the hydroxyl groups are not adjacent to one another; the chain structure consisting of aliphatic CH₂ groups, optionally with oxygen atoms (ether bridges) in between. (see the present specification, page 4, line 26, to page 5, line 1). Moreover, the specification sets forth the additional limitation that the linear dialcohol have a flash point higher than 100°C (see e.g., page 4, lines 22-25) and provides representative examples of suitable linear alcohols that can be used in the invention (see e.g., page 5, lines 1-10). Clearly, glycerine is not equivalent to the linear dialcohols required by the present invention.

However, even assuming *arguendo*, that the Fischer/Goller combination is proper, the resulting ink composition would have a concentration of linear dialcohol in the ink composition of 134 wt.% with respect to the water content (37.2g glycol / 27.7g water) -- far outside the range set forth in the present claims of 5 to 25 wt.%.

This low end range is necessary for the linear dialcohols of the present invention because their residues can contaminate the active sites of the electrocatalyst. Surprisingly, it has been found that the range of 5 to 25% for the concentration of the linear dialcohol, with respect to the water content of the ink, is ideal for high electrical performance of the resulting membrane electrode assembly.

Again, there is no teaching or suggestion in any of the cited references to induce one skilled in the industry to modify the concentration of the ethylene glycol of the hypothetical Fischer/Goller ink. The Campbell reference provides no help in this regard. Again, assuming *arguendo*, that it is proper to combine Campbell with Fischer and Goller (which Applicants maintain that it is not), the resulting ink composition would still have a concentration of linear dialcohol well outside the range set forth in the present claims. For instance, if the aqueous Nafion solution used in Applicants' examples (10 wt% in water) is substituted for the alcohol based solution of the hypothetical Fischer/Goller ink (based on the alleged suggestion in Campbell), the resulting ink composition would have a linear dialcohol concentration of 70.7 wt.% with respect to the water content -- 37.2g ethylene glycol / 52.6g water (24.8 g water plus 27.8g water from the Nafion solution - 90% of 30.9g).

This 70.7 wt.% concentration of linear dialcohol is still well outside of the range of 5 to 25% set forth in the present claims.

Accordingly, even if the cited references are combined in the manner suggested by the Examiner, the limitations of the present claims are not met. There is no teaching or suggestion in any of the cited references that the concentration of the linear dialcohol be in the range of 5 to 25 wt. % with respect to the water content of the ink.

In addition, changing the glycol concentration from the 70.7 wt.% concentration of the hypothetical ink of Fischer/Goller/Campbell to a percentage in the range of 5 to 25 wt.%, as required by the present claims, is beyond routine experimentation. Such a change would require the simultaneous variation of several parameters and thus create an endless number of experiments. For instance, a suitable solvent has to be selected; then, a suitable amount of the solvent has to be determined; and in addition, a suitable amount of water must be selected. Further, the other ink ingredients must be selected and their suitability determined with respect to the selected solvents and amounts (e.g., in the present invention, an aqueous solution of ionomer comprising predominantly water as solvent is used).

The present application teaches that an ink composition with the characteristics set forth in the claims results in improved adhesion to the membrane, good electrical performance and very good screen life (see, for instance, specification, page 5, lines 19-26). The inventors of the present invention discovered that an ink containing substantially water as a solvent has surprisingly good adhesion to the polymer membrane, among other properties, when the ink contains preferably 5 to 25 wt. % of a solvent from a group of specified linear dialcohols. The inventors further discovered (as already mentioned earlier) that inks with high concentrations of linear dialcohols (i.e., above the range of 5 to 25 wt.% with respect to the water content of the ink, as specified in claim 1) adversely effects the electrical performance of the resulting MEA - because the residual solvent in the deposited catalyst layers may contaminate and block the active catalyst sites.

The discovery that good electrical performance, longer screen life and improved adhesion of the catalyst layers may be achieved by means of controlling the ratio of linear dialcohol solvent vs. the total water content of the ink is novel and surprising, and certainly **not** obvious from the cited Fischer, Goller or Campbell references.

In light of the fact that each of the cited references fail to disclose or teach the ink composition of the presently pending claims - in particular, the claim limitation that the organic solvent is at least one linear dialcohol with a flash point higher than 100°C and being present in the ink in a concentration between 5 and 25 wt.% with respect to the water content of the ink - and fail to teach or suggest the unexpected advantages associated with the claimed invention, as outlined above, Applicants maintain that the present obviousness rejections are improper.

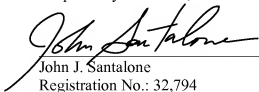
In view of the above arguments, Applicants respectfully request that the rejections set forth in the December 29th Office Action be withdrawn and that the application be deemed in condition for allowance.

No additional fee is believed to be due with respect to the filing of this reply, other than the fee for a three month extension of time. If any fee is due, please charge our Deposit Account No. 11-0171 for such sum.

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If the Examiner has any questions regarding the present application, the Examiner is cordially invited to contact Applicants' attorney at the telephone number provided below.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "John J. Santalone", is written over a horizontal line.

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